

FORM PTO-1390 (Modified) (REV 11-98)		U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		ATTORNEY'S DOCKET NUMBER <b>112740-206</b>	
INTERNATIONAL APPLICATION NO. <b>PCT/DE99/03166</b>		U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <b>09/807677</b>	
INTERNATIONAL FILING DATE <b>01 October 1999</b>		PRIORITY DATE CLAIMED <b>15 October 1998</b>	
TITLE OF INVENTION <b>MOBILE RADIO SYSTEM, AND MOBILE STATION</b>			
APPLICANT(S) FOR DO/EO/US <b>Ludwig Hofmann</b>			
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:			
<p>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.</p> <p>3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).</p> <p>4. <input checked="" type="checkbox"/> A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.</p> <p>5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c) (2))        a. <input checked="" type="checkbox"/> is transmitted herewith (required only if not transmitted by the International Bureau).        b. <input type="checkbox"/> has been transmitted by the International Bureau.        c. <input type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US).</p> <p>6. <input checked="" type="checkbox"/> A translation of the International Application into English (35 U.S.C. 371(c)(2)).</p> <p>7. <input checked="" type="checkbox"/> A copy of the International Search Report (PCT/ISA/210)</p> <p>8. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))        a. <input checked="" type="checkbox"/> are transmitted herewith (required only if not transmitted by the International Bureau).        b. <input type="checkbox"/> have been transmitted by the International Bureau.        c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.        d. <input type="checkbox"/> have not been made and will not be made.</p> <p>9. <input checked="" type="checkbox"/> A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).</p> <p>10. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).</p> <p>11. <input checked="" type="checkbox"/> A copy of the International Preliminary Examination Report (PCT/IPEA/409).</p> <p>12. <input type="checkbox"/> A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).</p>			
<p><b>Items 13 to 20 below concern document(s) or information included:</b></p> <p>13. <input type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98.</p> <p>14. <input checked="" type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.</p> <p>15. <input checked="" type="checkbox"/> A <b>FIRST</b> preliminary amendment.</p> <p>16. <input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.</p> <p>17. <input checked="" type="checkbox"/> A substitute specification.</p> <p>18. <input type="checkbox"/> A change of power of attorney and/or address letter.</p> <p>19. <input checked="" type="checkbox"/> Certificate of Mailing by Express Mail</p> <p>20. <input checked="" type="checkbox"/> Other items or information:</p>			
<p><b>Submission of Drawings Figures 1-6 on four sheets</b></p> <div style="border: 1px solid black; min-height: 100px; margin-top: 10px;"></div>			

U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR <b>04/807677</b>	INTERNATIONAL APPLICATION NO. <b>PCT/DE99/03166</b>	ATTORNEY'S DOCKET NUMBER <b>112740-206</b>
21. The following fees are submitted:		<b>CALCULATIONS PTO USE ONLY</b>
<b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :</b> <ul style="list-style-type: none"> <li><input type="checkbox"/> Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... <b>\$1,000.00</b></li> <li><input checked="" type="checkbox"/> International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... <b>\$860.00</b></li> <li><input type="checkbox"/> International preliminary examination fee (37 CFR 1.445(a)(2)) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... <b>\$710.00</b></li> <li><input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... <b>\$690.00</b></li> <li><input type="checkbox"/> International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(1)-(4) ..... <b>\$100.00</b></li> </ul>		
<b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>		<b>\$860.00</b>
Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)).		<input type="checkbox"/> 20 <input type="checkbox"/> 30 <b>\$0.00</b>
CLAIMS	NUMBER FILED	NUMBER EXTRA
Total claims	50 - 20 =	30 <input type="checkbox"/> \$18.00 <b>\$540.00</b>
Independent claims	2 - 3 =	0 <input type="checkbox"/> \$80.00 <b>\$0.00</b>
Multiple Dependent Claims (check if applicable).		<input type="checkbox"/> <b>\$0.00</b>
<b>TOTAL OF ABOVE CALCULATIONS =</b>		<b>\$1,400.00</b>
Reduction of 1/2 for filing by small entity, if applicable. Verified Small Entity Statement must also be filed (Note 37 CFR 1.9, 1.27, 1.28) (check if applicable).		<input type="checkbox"/> <b>\$0.00</b>
<b>SUBTOTAL =</b>		<b>\$1,400.00</b>
Processing fee of <b>\$130.00</b> for furnishing the English translation later than months from the earliest claimed priority date (37 CFR 1.492 (f)).		<input type="checkbox"/> 20 <input type="checkbox"/> 30 <b>\$0.00</b>
<b>TOTAL NATIONAL FEE =</b>		<b>\$1,400.00</b>
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) (check if applicable).		<input type="checkbox"/> <b>\$0.00</b>
<b>TOTAL FEES ENCLOSED =</b>		<b>\$1,400.00</b>
		<b>Amount to be: refunded      \$ charged      \$</b>

A check in the amount of **\$1,400.00** to cover the above fees is enclosed.

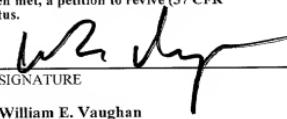
Please charge my Deposit Account No. **02-1818** in the amount of **\$** to cover the above fees.  
A duplicate copy of this sheet is enclosed.

The Commissioner is hereby authorized to charge any fees which may be required, or credit any overpayment to Deposit Account No. **02-1818** A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

William E. Vaughan  
Bell, Boyd & Lloyd LLC  
P.O. Box 1135  
Chicago, IL 60690-1135

  
**SIGNATURE**

William E. Vaughan

NAME

**39,056**

REGISTRATION NUMBER

April 16, 2001

DATE

BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE  
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE  
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

5

APPLICANT: Ludwig Hofmann DOCKET NO: 112740-206

SERIAL NO: GROUP ART UNIT:

EXAMINER:

10 INTERNATIONAL APPLICATION NO: PCT/DE99/03166

INTERNATIONAL FILING DATE: 01 October 1999

INVENTION: MOBILE RADIO SYSTEM, AND MOBILE STATION

15 Assistant Commissioner for Patents,  
Washington, D.C. 20231

SUBMISSION OF DRAWINGS

20 Applicant herewith submits four sheets (Figs. 1-6) of drawings for the  
above-referenced PCT application.

Respectfully submitted,



(Reg. No. 39,056)

25 William E. Vaughan  
Bell, Boyd & Lloyd LLC  
P.O. Box 1135  
Chicago, Illinois 60690-1135  
(312) 807-4292

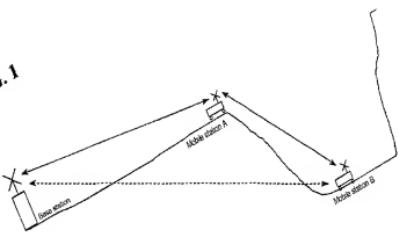
30 Attorneys for Applicant

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0,1807677

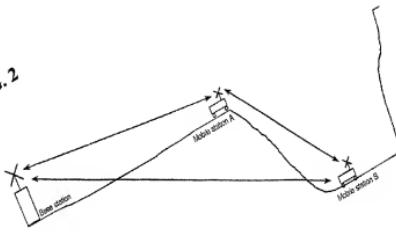
1/4

FIG. 1



0,1807677  
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FIG. 2



09/807677

FIG. 3

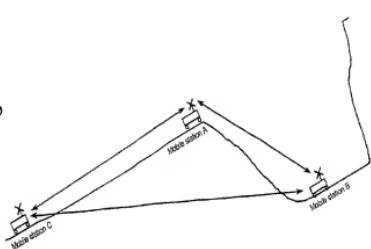
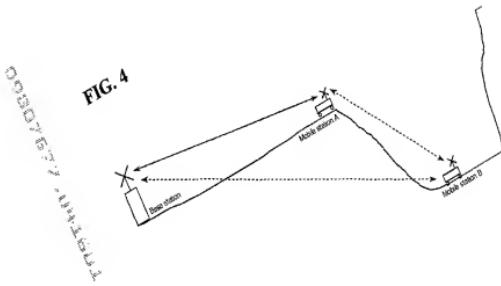
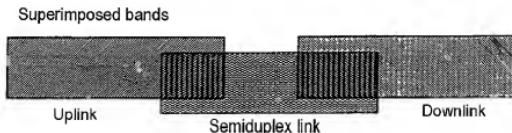


FIG. 4



**FIG. 5a****FIG. 5b**

**FIG. 6a**

0	1	2	3	4	5	6	7	0	1
RXs	TXs				RXs				

**FIG. 6b**

0	1	2	3	4	5	6	7	0	1
RX	TX				RX				

**FIG. 6c**

0	1	2	3	4	5	6	7	0	1
RX	RXs	TX		TXs		RX		RXs	

5 BOX PCT

IN THE UNITED STATES ELECTED/DESIGNATED OFFICE  
OF THE UNITED STATES PATENT AND TRADEMARK OFFICE  
UNDER THE PATENT COOPERATION TREATY-CHAPTER II

PRELIMINARY AMENDMENT

APPLICANT: Ludwig Hofmann DOCKET NO: 112740-206

SERIAL NO: GROUP ART UNIT:

10 EXAMINER:

INTERNATIONAL APPLICATION NO: PCT/DE99/03166

INTERNATIONAL FILING DATE: 01 October 1999

INVENTION: MOBILE RADIO SYSTEM, AND MOBILE STATION

15 Assistant Commissioner for Patents,  
Washington, D.C. 20231

Sir:

20 Please amend the above-identified International Application before entry into the  
National stage before the U.S. Patent and Trademark Office under 35 U.S.C. §371 as follows:

**In the Specification:**

Please replace the Specification of the present application, including the Abstract,  
with the following Substitute Specification:

**S P E C I F I C A T I O N**

**TITLE**

**MOBILE RADIO SYSTEM, AND MOBILE STATION**

**BACKGROUND OF THE INVENTION**

**Field of the Invention**

25 The present invention relates to a mobile radio system and to a mobile station which  
are suitable for carrying out transmission/reception operation in the duplex and semiduplex  
mode.

**Description of the Prior Art**

30 Previous mobile radio systems operating in the duplex mode operate at specific uplink  
and downlink frequencies, with each mobile station needing to have a direct link to a base  
station. In this case, signals between two mobile stations are not transmitted directly from one

mobile station to the other, but via one or more base stations depending on the location of the mobile stations. If there is no link from the mobile stations to a base station, no link can be set up to another mobile station. Such a situation is shown in Figure 4. Although, as shown in Figure 4, the mobile station A can set up a link to the base station, the mobile station B 5 cannot, since it is out of range of the base station (for example, in a valley or on a bridge). No link, therefore, can be set up between the mobile stations A and B even if, for example, there is a visual link between them. Since it has so far not been possible to overcome this disadvantage with mobile radio systems operating in the duplex mode, additional systems such as TETRA (Trans European Trunked Radio Access) have been developed and 10 constructed, in which communication takes place directly between two mobile radios without using a base station. However, a mobile radio system operating in the duplex mode is advantageous for effective use of the available frequencies and base stations.

15 An object of the present invention is, thus, to provide a mobile radio system and a mobile station which, in addition to transmission/reception operation in the duplex mode, are also suitable for transmission/reception operation in the non-duplex mode.

#### **SUMMARY OF THE INVENTION**

Accordingly, a mobile radio system having a number of mobile stations is provided, 20 in which the mobile stations carry out transmission/reception operation in the duplex mode and in the semiduplex mode. The mobile stations are, thus, suitable for setting up communication to one or more mobile stations using the duplex and/or semiduplex mode.

According to one embodiment of the present invention, a first mobile station carries 25 out transmission/reception operation with a base station in the duplex mode, and with a second mobile station in the semiduplex mode. This allows simultaneous communication to be set up from the first mobile station in the duplex mode to the base station and to a second mobile station in the semiduplex mode, even when there is no link from the second mobile station to the base station.

Furthermore, transmission/reception operation can be carried out with the base station 30 in the duplex mode and with the second mobile station in the semiduplex mode, such that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another. The timeslots for the duplex and semiduplex mode, thus can be superimposed (interleaved) in

such a manner that the transmission/ reception operation is carried out virtually simultaneously in the duplex and semiduplex mode without any mutual influence.

If the first mobile station carries out transmission/ reception operation with the base station in the duplex mode and with the second mobile station in the 5 semiduplex mode, such that signals from the base station are transmitted via the first mobile station to the second mobile station and vice versa, communication can be set up between the base station and the second mobile station with the interposition of the first mobile station as a repeater. This can be done even when there is no direct link from the second mobile station to the base station.

10 In accordance with another embodiment of the present invention, the first mobile station carries out transmission/reception operation with the second mobile station and with a third mobile station in the semiduplex mode. This allows simultaneous communication to be set up directly from the first mobile station to the second and third mobile station in the semiduplex mode without any link to a base station.

15 If the first mobile station carries out transmission/ reception operation with the second and the third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the one mobile station to the third mobile station and vice versa, communication can be set up between the second and third mobile station with the interposition of the one mobile station as a repeater even when there is no link between the second and third mobile station and any base station.

20 If a number of mobile stations are coupled to one another, then a communication chain or communication network of any desired size can be produced, in which case communication can be set up via a number of mobile stations with or without using base stations.

25 In order to avoid loading the power supply device of the first mobile station in an uncontrolled manner, the first mobile station manually or automatically switches on and off the transmission of signals from the second mobile station via the first mobile station to the base station or to the third mobile station, and vice versa. The function of the first mobile station as a repeater, thus, can be activated or deactivated.

30 Additional features and advantages of the present invention are described in, and will be apparent from, the following Detailed Description of the Preferred Embodiments and the Drawings.

## **DESCRIPTION OF THE DRAWINGS**

Figures 1 to 3 show various embodiments and operating modes of a mobile radio system according to the present invention;

5 Figure 4 shows a mobile radio system according to the prior art;

Figure 5 shows an illustration of frequency bands used in connection with the present invention; and

10 Figure 6 shows an illustration of timeslots used in connection with the present invention.

## **DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

15 Conventional mobile radio systems, such as the GSM system, operate in the duplex mode and generally use a timeslot method in which the transmitter and receiver are active at different times. The transmitter in this case operates in the uplink frequency band, while the receiver operates in the downlink frequency band.

20 In the present invention, a semiduplex band is required as an additional band. As shown in Figure 5a, such a band may lie in another frequency band or, as shown in Figure 5b, may be arranged such that it is superimposed on the uplink and downlink frequencies.

25 Figure 6 shows a transmission/reception process within a transmission/reception cycle which is subdivided into eight timeslots (0 to 7). The semiduplex band (see Figure 6a) allows transmission and reception at the same frequency, with transmission and reception each being carried out in different timeslots. The reference symbol RXs in this case denotes reception, and TXs transmission of signals in the semiduplex band. The semiduplex band timeslots are synchronized to the duplex band timeslots (see Figure 6b) as in the GSM system, but they may differ both in the nature of the transmission and in length. The reference symbol RX denotes reception and TX denotes transmission of signals in the duplex band. Overall, this makes it is possible to work virtually simultaneously in both bands (see Figure 6c).

30 As shown in Figure 1, a mobile station A communicates with the base station using the duplex mode. In addition, the mobile station A can set up communication using the semiduplex mode with the mobile station B. There is no link between the mobile station B and the base station. It is, thus, possible for the mobile station A to communicate simultaneously with the base station and the mobile station B.

Figure 2 shows a situation in which the mobile station A is being used as a repeater. As in the situation shown in Figure 1, there is a direct link between the base station and the mobile station A, while there is no direct link between the base station and the mobile station B. However, the mobile station A converts the semiduplex mode information transmission to 5 duplex mode information transmission, and vice versa, so that communication is set up between the base station and the mobile station B. As such, data is transmitted using the semiduplex mode from the mobile station B to the mobile station A, processed in the mobile station A and passed on using the duplex mode to the base station. In the opposite direction, the data is transmitted from the base station to the mobile station A using the duplex mode, 10 processed in the mobile station A, and passed on to the mobile station B using the semiduplex mode.

As shown in Figure 3, it is likewise possible for the mobile station A to communicate simultaneously with the mobile station B and the mobile station C using the semiduplex mode or, as a repeater, to receive information in the semiduplex mode from the mobile station B, and to pass it on to the other mobile station C using the semiduplex mode (or vice versa). Direct coupling between the mobile stations B and C would be impossible since the mobile station B is located in an area (valley) which is shadowed from the mobile station C.

It is also possible to form a chain which includes a greater number of mobile stations.

The mobile stations have a control device which chooses between operation with one or 15 two further stations or else operation as a repeater. If required, the control device may automatically select operation as a repeater. However, in order to avoid loading the power supply device in a mobile station in an uncontrolled manner, operation as a repeater can be inhibited.

The advantage of the mobile radio system in the present invention, in which mobile 20 stations can be operated as repeaters, is, as described above, that even mobile stations which have no direct link to a base station due to shadowing can set up communication to other mobile stations and to the base station. A further advantage is that a mobile station likewise can be operated from an aircraft. In a conventional mobile radio system, operation of a mobile station from an aircraft while flying is normally impossible since the mobile station cannot set 25 up communication with a specific base station from the large number of accessible base stations. By using mobile stations as repeaters which operate at a frequency suitable for them, however, it is possible to set up communication with one base station.

Furthermore, the mobile radio system in the present invention can be designed to be self organizing. By using new transmission methods such as JD-CMDA, it can provide very high transmission capacities. Such a combined system makes it possible to integrate virtually all the radio and mobile requirements which arise and operate with limited range 5 and, possibly, with high traffic densities; such as wireless LAN, DSSR digital short range radio, LPD low power devices, TETRA trunked mobile radio and BOS, railroad radio, cordless telephones, mobile telephones, aviation radio, maritime radio, emergency paging systems and cordless buses (for control functions).

In one design variant of the present invention, the term duplex mode refers to a 10 frequency division duplex (FDD) mode, and the term semiduplex mode refers to a time division duplex (TDD) mode. In this case, different frequency bands can be provided for the uplink (mobile station to base station) for FDD (Frequency Division Duplex) systems, such as the GSM system or UTRA (UMTS (Universal Mobile Telephony System) Terrestrial Radio Access) FDD mode than for the downlink (base station to mobile station), and different 15 time periods can be provided for the uplink and downlink for TDD (Time Division Duplex) systems such as DECT (Digital Enhanced Cordless Telecommunications) system or the UTA (UMTS (Universal Mobile Telephony System) Terrestrial Radio Access) TDD mode.

Although the present invention has been described with reference to specific 20 embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereinafter appended claims.

#### ABSTRACT OF THE DISCLOSURE

A mobile radio system containing a number of mobile stations, with the mobile 25 stations having the ability to carry out transmission/reception operation in the duplex mode and in the semiduplex mode.

#### In the claims:

On page 8, cancel line 1, and substitute the following left-hand justified heading therefor:

#### I Claim as My Invention:

30 Please cancel claims 1-15, without prejudice and substitute the following claims therefor:

16. A mobile radio system, comprising:

at least one base station; and

each of the plurality of mobile stations able to carry out transmission and reception operations in both a duplex mode and a semiduplex mode, the duplex mode being a frequency division duplex mode and the semiduplex mode being a time division duplex mode;

wherein the first mobile station simultaneously carries out transmission and reception operations with the at least one base station in the duplex mode and carries out transmission and reception operations with the second mobile station in the semiduplex mode.

10 17. A mobile radio system as claimed in claim 16, wherein the transmission and reception operations of the first mobile station are carried out cyclically in time slots, the time slots for the duplex and semiduplex modes running synchronously with respect to one another.

15 18. A mobile radio system as claimed in claim 16, wherein signals from the second mobile station are transmitted via the first mobile station to the base station, and signals from the base station are transmitted via the first mobile station to the second mobile station.

20 19. A mobile radio system as claimed in claim 17, wherein signals from the second mobile station are transmitted via the first mobile station to the base station, and signals from the base station are transmitted via the first mobile station to the second mobile station.

25 20. A mobile radio system as claimed in claim 16, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode.

30 21. A mobile radio system as claimed in claim 17, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode.

22. A mobile radio system as claimed in claim 18, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode.

5 23. A mobile radio system as claimed in claim 19, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode.

10 24. A mobile radio system as claimed in claim 16, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

15 25. A mobile radio system as claimed in claim 17, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

20 26. A mobile radio system as claimed in claim 18, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

25 27. A mobile radio system as claimed in claim 19, wherein the first mobile station further carries out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

28. A mobile radio system as claimed in claim 24, wherein the plurality of mobile stations are coupled to one another to form at least one of a communication chain and a communication network.

5 29. A mobile radio system as claimed in claim 16, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

10 30. A mobile radio system as claimed in claim 17, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

15 31. A mobile radio system as claimed in claim 18, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

20 32. A mobile radio system as claimed in claim 19, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

25 33. A mobile radio system as claimed in claim 20, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station

and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

34. A mobile radio system as claimed in claim 21, wherein the first mobile station  
5 may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

10 35. A mobile radio system as claimed in claim 22, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

15 36. A mobile radio system as claimed in claim 23, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

20 37. A mobile radio system as claimed in claim 24, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

30 38. A mobile radio system as claimed in claim 25, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

39. A mobile radio system as claimed in claim 26, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

40. A mobile radio system as claimed in claim 27, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

41. A mobile radio system as claimed in claim 28, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

42. A mobile station in a mobile radio system, comprising a part for simultaneously carrying out transmission and reception operations with a base station in the mobile radio system in a duplex mode, and carrying out transmission and reception operations with a second mobile radio station in the mobile radio system in a semiduplex mode, wherein the duplex mode is a frequency division duplex mode and the semiduplex mode is a time division duplex mode.

43. A mobile station in a mobile radio system as claimed in claim 42, wherein the transmission and reception operations of the first mobile station are carried out cyclically in time slots, the time slots for the duplex and semiduplex modes running synchronously with respect to one another.

44. A mobile station in a mobile radio system as claimed in claim 42, wherein signals from the second mobile station are transmitted via the first mobile station to the base station, and signals from the base station are transmitted via the first mobile station to the second mobile station.

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45. A mobile station in a mobile radio system as claimed in claim 43, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

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46. A mobile station in a mobile radio system as claimed in claim 42, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode.

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47. A mobile station in a mobile radio system as claimed in claim 43, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode.

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48. A mobile station in a mobile radio system as claimed in claim 44, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode.

25

49. A mobile station in a mobile radio system as claimed in claim 45, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode.

30

50. A mobile station in a mobile radio system as claimed in claim 42, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station

are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

5        51.    A mobile station in a mobile radio system as claimed in claim 43, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

10        52.    A mobile station in a mobile radio system as claimed in claim 44, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

15        53.    A mobile station in a mobile radio system as claimed in claim 45, further comprising a part for additionally carrying out transmission and reception operations with a third mobile station in the semiduplex mode, such that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and signals from the third mobile station are transmitted via the first mobile station to the second mobile station.

20        54.    A mobile station in a mobile radio system as claimed in claim 42, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

25        55.    A mobile station in a mobile radio system as claimed in claim 43, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

56. A mobile station in a mobile radio system as claimed in claim 44, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

57. A mobile station in a mobile radio system as claimed in claim 45, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to the base station, and the transmission of signals from the base station via the first mobile station to the second mobile station.

58. A mobile station in a mobile radio system as claimed in claim 46, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

59. A mobile station in a mobile radio system as claimed in claim 47, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at least one of the base station and the third mobile station via the first mobile station to the second mobile station.

60. A mobile station in a mobile radio system as claimed in claim 48, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at

least one of the base station and the third mobile station via the first mobile station to the second mobile station.

61. A mobile station in a mobile radio system as claimed in claim 49, wherein the  
5 first mobile station may switch on and off, at least one of manually and automatically, the  
transmission of signals from the second mobile station via the first mobile station to at least  
one of the base station and the third mobile station, and the transmission of signals from at  
least one of the base station and the third mobile station via the first mobile station to the  
second mobile station.

10

62. A mobile station in a mobile radio system as claimed in claim 50, wherein the  
first mobile station may switch on and off, at least one of manually and automatically, the  
transmission of signals from the second mobile station via the first mobile station to at least  
one of the base station and the third mobile station, and the transmission of signals from at  
least one of the base station and the third mobile station via the first mobile station to the  
second mobile station.

63. A mobile station in a mobile radio system as claimed in claim 51, wherein the  
first mobile station may switch on and off, at least one of manually and automatically, the  
transmission of signals from the second mobile station via the first mobile station to at least  
one of the base station and the third mobile station, and the transmission of signals from at  
least one of the base station and the third mobile station via the first mobile station to the  
second mobile station.

25 64. A mobile station in a mobile radio system as claimed in claim 52, wherein the  
first mobile station may switch on and off, at least one of manually and automatically, the  
transmission of signals from the second mobile station via the first mobile station to at least  
one of the base station and the third mobile station, and the transmission of signals from at  
least one of the base station and the third mobile station via the first mobile station to the  
30 second mobile station.

65. A mobile station in a mobile radio system as claimed in claim 53, wherein the first mobile station may switch on and off, at least one of manually and automatically, the transmission of signals from the second mobile station via the first mobile station to at least one of the base station and the third mobile station, and the transmission of signals from at 5 least one of the base station and the third mobile station via the first mobile station to the second mobile station.

**REMARKS**

The present amendment makes editorial changes and corrects typographical errors in the specification, which includes the Abstract, in order to conform the specification to the 10 requirements of United States Patent Practice. No new matter is added thereby. Attached hereto is a marked-up version of the changes made to the specification by the present amendment. The attached page is captioned "**Version With Markings To Show Changes** 15 **Made**".

In addition, the present amendment cancels original claims 1-15 in favor of new 20 claims 16-65. Claims 16-65 have been presented solely because the revisions by red-lining and underlining which would have been necessary in claims 1-15 in order to present those claims in accordance with preferred United States Patent Practice would have been too extensive, and thus would have been too burdensome. The present amendment is intended for clarification purposes only and not for substantial reasons related to patentability pursuant to 35 USC §§103, 102, 103 or 112. Indeed, the cancellation of claims 1-15 does not constitute an intent on the part of the Applicants to surrender any of the subject matter of claims 1-15.

Early consideration on the merits is respectfully requested.

Respectfully submitted,

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(Reg. No. 39,056)

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William E. Vaughan  
Bell, Boyd & Lloyd LLC  
P.O. Box 1135  
Chicago, Illinois 60690-1135  
(312) 807-4292  
Attorneys for Applicant

**VERSIONS WITH MARKINGS TO SHOW CHANGES MADE**

**In The Specification:**

The Specification of the present application, including the Abstract, has been amended as follows:

**S P E C I F I C A T I O N**

**TITLE**

**MOBILE RADIO SYSTEM, AND MOBILE STATION**

**BACKGROUND OF THE INVENTION**

5   **Field of the Invention**

The present invention relates to a mobile radio system and to a mobile station which are suitable for carrying out transmission/reception operation in the duplex and semiduplex mode.

10   **Description of the Prior Art**

Previous mobile radio systems operating in the duplex mode operate at specific uplink and downlink frequencies, with each mobile station needing to have a direct link to a base station. In this case, signals between two mobile stations are not transmitted directly from one mobile station to the other, but via one or more base stations depending on the location of the mobile stations. If there is no link from the mobile stations to a base station, no link can be set up to another mobile station. Such a situation is shown in Figure 4. Although, as shown in Figure 4, the mobile station A can set up a link to the base station, the mobile station B cannot, since it is out of range of the base station (for example in a valley or on a bridge). No link, therefore, can therefore be set up between the mobile stations A and B even if, for example, there is a visual link between them. Since it has so far not been possible to

15   overcome this disadvantage with mobile radio systems operating in the duplex mode, additional systems such as TETRA (Trans European Trunked Radio Access) have been developed and constructed, in which communication takes place directly between two mobile radios, without using a base station. However, a mobile radio system operating in the duplex mode is advantageous for effective use of the available frequencies and base stations.

20   The An object of the present invention is, thus, to provide a mobile radio system and a mobile station which, in addition to transmission/reception operation in the duplex mode, are also suitable for transmission/reception operation in the non-duplex mode.

The object is achieved by the features of the independent claims.

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## SUMMARY OF THE INVENTION

Accordingly, a mobile radio system having a number of mobile stations is provided, in which the mobile stations ~~have means for carrying~~ carry out transmission/reception operation in the duplex mode and in the semiduplex mode. The mobile stations are, thus,  
5 suitable for setting up communication to one or more mobile stations using the duplex and/or semiduplex mode.

According to one embodiment of the present invention, a first mobile station ~~contains~~ means for carrying carries out transmission/reception operation with a base station in the duplex mode, and with a second mobile station in the semiduplex mode, ~~thus allowing~~ This  
10 allows simultaneous communication to be set up from the first mobile station in the duplex mode to the base station and to a second mobile station in the semiduplex mode, even when there is no link from the second mobile station to the base station.

Furthermore, ~~means are provided for carrying out~~ transmission/reception operation can be carried out with the base station in the duplex mode and with the second mobile station in the semiduplex mode, ~~in such a manner~~ that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another. The timeslots for the duplex and semiduplex mode, ~~thus~~ can thus be superimposed (interleaved) in such a manner that the transmission/reception operation is carried out virtually simultaneously in the duplex and semiduplex mode without any mutual influence.  
20

If the first mobile station ~~is provided with means for carrying~~ carries out transmission/reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, ~~in such a manner~~ that signals from the base station are transmitted via the first mobile station to the second mobile station and vice versa,  
25 communication can be set up between the base station and the second mobile station with the interposition of the first mobile station as a repeater. This can be done even when there is no direct link from the second mobile station to the base station.

In accordance with another embodiment of the present invention, the first mobile station ~~contains means for carrying~~ carries out transmission/reception operation with the second mobile station and with a third mobile station in the semiduplex mode, ~~thus allowing~~ This allows simultaneous communication to be set up directly from the first mobile station to the second and third mobile station in the semiduplex mode without any link to a base station.  
30

1 If the first mobile station is provided with means for carrying carries out transmission/reception operation with the second and the third mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the one mobile station to the third mobile station and vice versa, communication can be set up between the 5 second and third mobile station with the interposition of the one mobile station as a repeater even when there is no link between the second and third mobile station and any base station.

10 If a number of mobile stations are coupled to one another, then a communication chain or communication network of any desired size can be produced, in which case communication can be set up via a number of mobile stations with or without using base stations.

15 In order to avoid loading the power supply device of the first mobile station in an uncontrolled manner, the first mobile station is equipped with means for manually or automatically switching switches on and off the transmission of signals from the second mobile station via the first mobile station to the base station or to the third mobile station, and vice versa. The function of the first mobile station as a repeater, thus can thus be activated or deactivated.

20 Additional features and advantages of the present invention are described in, and will be apparent from, the Detailed Description of the Preferred Embodiments and the Drawings.

#### DESCRIPTION OF THE DRAWINGS

25 The present invention will be explained in the following description with reference to the drawing.

Figures 1 to 3 show various embodiments and operating modes of a mobile radio system according to the present invention;

Figure 4 shows a mobile radio system according to the prior art;

Figure 5 shows an illustration of frequency bands to be used in connection with the present invention; and

Figure 6 shows an illustration of timeslots to be used in connection with the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

30 Conventional mobile radio systems, such as the GSM system, operate in the duplex mode and generally use a timeslot method in which the transmitter and receiver are

active at different times. The transmitter in this case operates in the uplink frequency band, while the receiver operates in the downlink frequency band.

In the present invention, a semiduplex band is required as an additional band. As shown in Figure 5a, such a band may lie in another frequency band or, as shown in figure

5 Figure 5b, may be arranged such that it is superimposed on the uplink and downlink frequencies.

Figure 6 shows a transmission/reception process within a transmission/reception cycle which is subdivided into eight timeslots (0 to 7). The semiduplex band (see Figure 6a)

10 allows transmission and reception at the same frequency, with transmission and reception each being carried out in different timeslots. The reference symbol RXs in this case denotes reception, and TXs transmission of signals in the semiduplex band. The semiduplex band timeslots are synchronized to the duplex band timeslots (see Figure 6b) as in the GSM system, but they may differ both in the nature of the transmission, and in length. The reference symbol RX denotes reception and TX denotes transmission of signals in the duplex band. Overall, this means makes that it is possible to work virtually simultaneously in both bands (see Figure 6c).

15 As shown in Figure 1, a mobile station A communicates with the base station using the duplex mode. In addition, the mobile station A can set up communication using the semiduplex mode with the mobile station B. There is no link between the mobile station B and the base station. It is, thus, possible for the mobile station A to communicate 20 simultaneously with the base station and the mobile station B.

Figure 2 shows a situation in which the mobile station A is being used as a repeater. As in the situation shown in Figure 1, there is a direct link between the base station and the mobile station A, while there is no direct link between the base station and the mobile station

25 B. However, the mobile station A converts the semiduplex mode information transmission to duplex mode information transmission, and vice versa, so that communication is set up between the base station and the mobile station B. This means that As such, data are is transmitted using the semiduplex mode from the mobile station B to the mobile station A, are processed in the mobile station A and are passed on using the duplex mode to the base 30 station, and, in In the opposite direction, are the data is transmitted from the base station to the mobile station A using the duplex mode, are processed in the mobile station A, and are passed on to the mobile station B using the semiduplex mode.

As shown in Figure 3, it is likewise possible for the mobile station A to communicate simultaneously with the mobile station B and the mobile station C using the semiduplex mode or, as a repeater, to receive information in the semiduplex mode from the mobile station B, and to pass it on to the other mobile station C using the semiduplex mode (or vice versa).

5 Direct coupling between the mobile stations B and C would be impossible since the mobile station B is located in an area (valley) which is shadowed from the mobile station C.

It is also possible to form a chain ~~comprising~~ which includes a greater number of mobile stations.

The mobile stations have a control device which chooses between operation with one or 10 two further stations or else operation as a repeater. If required, the control device may automatically select operation as a repeater. However, in order to avoid loading the power supply device in a mobile station in an uncontrolled manner, operation as a repeater can be inhibited.

The advantage of the mobile radio system in the present invention, in which mobile stations can be operated as repeaters, is, as described above, that even mobile stations which have no direct link to a base station due to shadowing can set up communication to other mobile stations and to the base station. A further advantage is that a mobile station ~~can~~ 15 likewise ~~can~~ be operated from an aircraft. In a conventional mobile radio system, operation of a mobile station from an aircraft while flying is normally impossible since the mobile station cannot set up communication with a specific base station from the large number of accessible base stations. By using mobile stations as repeaters which operate at a frequency suitable for them, however, it is possible to set up communication with one base station.

Furthermore, the mobile radio system in the present invention can be designed to be 20 self organizing. By using new transmission methods such as JD-CMDA, it can provide very high transmission capacities. Such a combined system makes it possible to integrate virtually all the radio and mobile requirements which arise and operate with limited range and, possibly, with high traffic densities; such as wireless LAN, DSSR digital short range radio, LPD low power devices, TETRA trunked mobile radio and BOS, railroad radio, cordless telephones, mobile telephones, aviation radio, maritime radio, emergency paging 25 systems and cordless buses (for control functions).

In one design variant of the present invention, the term duplex mode ~~means~~ refers to a frequency division duplex (FDD) mode, and the term semiduplex mode ~~means~~ refers to a

time division duplex (TDD) mode. In this case, different frequency bands can be provided for the uplink (mobile station to base station) for FDD (Frequency Division Duplex) systems, such as the GSM system or UTRA (UMTS (Universal Mobile Telephony System) Terrestrial Radio Access) FDD mode than for the downlink (base station to mobile station), and different time periods can be provided for the uplink and downlink for TDD (Time Division Duplex) systems such as DECT (Digital Enhanced Cordless Telecommunications) system or the UTA (UMTS (Universal Mobile Telephony System) Terrestrial Radio Access) TDD mode.

Although the present invention has been described with reference to specific embodiments, those of skill in the art will recognize that changes may be made thereto without departing from the spirit and scope of the invention as set forth in the hereafter appended claims.

### **ABSTRACT OF THE DISCLOSURE**

A mobile radio system ~~contains~~ containing a number of mobile stations, with the mobile stations having means for carrying the ability to carry out transmission/reception operation in the duplex mode and in the semiduplex mode.

Patent Claims

1. A mobile radio system having a number of mobile stations (A, B, C),

5 with the mobile stations having means for carrying out transmission/reception operation in the duplex mode and in the semiduplex mode,

10 with a first mobile station (A) having means for simultaneously carrying out transmission/reception operation with a base station in the duplex mode and with a second mobile station (B) in the semiduplex mode, and

15 the duplex mode being in the form of the frequency division duplex mode, and the semiduplex mode being in the form of the time division duplex mode.

2. The mobile radio system as claimed in claim 1, characterized in that the first mobile station (A) has means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode in such a manner that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another.

25 3. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the base station, and vice versa.

30 4. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for carrying out transmission/reception

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operation with the second mobile station (B) and with a third mobile station (C) in the semiduplex mode.

5. The mobile radio system as claimed in one of the preceding claims, characterized in that the first 5 mobile station (A) has means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile 10 station to the third mobile station, and vice versa.

6. The mobile radio system as claimed in one of the preceding claims, characterized in that the mobile stations that are among the number of mobile stations are coupled to one another in such a manner that a 15 communication chain or a communication network is formed.

7. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for manually or 20 automatically switching on and off the transmission of signals from the second mobile station (B) via the first mobile station (A) to the base station or to the third mobile station (C), and vice versa.

8. A mobile station (A) 25 having means for simultaneously carrying out transmission/reception operation with a base station in the duplex mode and with a second mobile station (B) in the semiduplex mode, with the duplex mode being in the form of the frequency 30 division duplex mode, and the semiduplex mode being in the form of a time division duplex mode.

9. The mobile station (A) as claimed in claim 8, having means for carrying out transmission/reception operation with the base station in the duplex mode and 35 with the second mobile station (B) in the semiduplex mode, in such a manner that the

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transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another.

5 10. The mobile station (A) as claimed in one of claims 8 to 9, having means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode, in such a manner that 10 signals from the second mobile station are transmitted via the first mobile station to the base station, and vice versa.

11. The mobile station (A) as claimed in one of claims 8 to 10, having means for carrying out 15 transmission/reception operation with the second mobile station (B) and with a third mobile station (C) in the semiduplex mode.

12. The mobile station (A) as claimed in one of claims 8 to 11, having means for carrying out 20 transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and vice versa.

25 13. The mobile station (A) as claimed in one of claims 8 to 12, having means for manually or automatically switching on and off the transmission of signals from the second mobile station (B) via the first mobile station (A) to the base station or to the 30 third mobile station (C), and vice versa.

14. The mobile station (A) as claimed in one of claims 9 to 13, having means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex 35 mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the third mobile station, and vice versa.

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15. The mobile station (A) as claimed in one of  
claims 9 to 14, having means for manually or  
automatically switching on and off the transmission of  
signals from the second mobile station (B) via the  
5 first mobile station (A) to the base station or to the  
third mobile station (C), and vice versa.

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## Description

Mobile radio system, and a mobile station

5 The present invention relates to a mobile radio system and to a mobile station which are suitable for carrying out transmission/reception operation in the duplex and semiduplex mode.

10 Previous mobile radio systems operating in the duplex mode operate at specific uplink and downlink frequencies, with each mobile station needing to have a direct link to a base station. In this case, signals between two mobile stations are not transmitted directly from one mobile station to the other, but via 15 one or more base stations depending on the location of the mobile stations. If there is no link from the mobile stations to a base station, no link can be set up to another mobile station. Such a situation is shown in Figure 4. Although, as shown in Figure 4, the mobile 20 station A can set up a link to the base station, the mobile station B cannot, since it is out of range of the base station (for example in a valley or on a bridge). No link can therefore be set up between the mobile stations A and B even if, for example, there is 25 a visual link between them. Since it has so far not been possible to overcome this disadvantage with mobile radio systems operating in the duplex mode, additional systems such as TETRA (Trans European Trunked Radio Access) have been developed and constructed, in which 30 communication takes place directly between two mobile radios, without using a base station. However, a mobile radio system operating in the duplex mode is advantageous for effective use of the available frequencies and base stations.

35 The object of the present invention is thus to provide a mobile radio system and a mobile station which, in addition

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to transmission/reception operation in the duplex mode, are also suitable for transmission/reception operation in the non-duplex mode.

5 The object is achieved by the features of the independent claims.

Accordingly, a mobile radio system having a number of mobile stations is provided, in which the mobile stations have means for carrying out transmission/reception operation in the duplex mode and 10 in the semiduplex mode. The mobile stations are thus suitable for setting up communication to one or more mobile stations using the duplex and/or semiduplex mode.

According to one embodiment of the present 15 invention, a first mobile station contains means for carrying out transmission/reception operation with a base station in the duplex mode, and with a second mobile station in the semiduplex mode, thus allowing simultaneous communication to be set up from the first 20 mobile station in the duplex mode to the base station and to a second mobile station in the semiduplex mode, even when there is no link from the second mobile station to the base station.

Furthermore, means are provided for carrying 25 out transmission/reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, in such a manner that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the 30 duplex and semiduplex mode run synchronously with respect to one another. The timeslots for the duplex and semiduplex mode can thus be superimposed (interleaved) in such a manner that the transmission/reception operation is carried out virtually 35 simultaneously in the duplex and semiduplex mode without any mutual influence.

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If the first mobile station is provided with means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station in the semiduplex mode, in such a 5 manner that signals from the base station are transmitted via the first mobile station to the second mobile station and vice versa, communication can be set up between the base station and the second mobile station with the interposition of the first mobile 10 station as a repeater, even when there is no direct link from the second mobile station to the base station.

In accordance with another embodiment, the first mobile station contains means for carrying out 15 transmission/reception operation with the second mobile station and with a third mobile station in the semiduplex mode, thus allowing simultaneous communication to be set up directly from the first mobile station to the second and third mobile station 20 in the semiduplex mode without any link to a base station.

If the first mobile station is provided with means for carrying out transmission/reception operation with the second and the third mobile station in the 25 semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the one mobile station to the third mobile station and vice versa, communication can be set up between the second and third mobile station with the interposition of the 30 one mobile station as a repeater even when there is no link between the second and third mobile station and any base station.

If a number of mobile stations are coupled to one another, then a communication chain or 35 communication network of any desired size can be produced, in which case communication can be set up via a number of mobile stations with or without using base stations.

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In order to avoid loading the power supply device of the first mobile station in an uncontrolled manner, the first mobile station is equipped with means for manually or automatically switching on and off the 5 transmission of signals from the second mobile station via the first mobile station to the base station or to the third mobile station, and vice versa. The function of the first mobile station as a repeater can thus be activated or deactivated.

10 The present invention will be explained in the following description with reference to the drawing.

Figures 1 to 3 show various embodiments and operating modes of a mobile radio system according to the present invention;

15 Figure 4 shows a mobile radio system according to the prior art;

Figure 5 shows an illustration of frequency bands to be used; and

20 Figure 6 shows an illustration of timeslots to be used.

Conventional mobile radio systems, such as the GSM system, operate in the duplex mode and generally using a timeslot method in which the transmitter and receiver are active at different times. The transmitter 25 in this case operates in the uplink frequency band, while the receiver operates in the downlink frequency band.

In the present invention, a semiduplex band is required as an additional band. As shown in Figure 5a, 30 such a band may lie in another frequency band or, as shown in figure 5b, may be arranged such that it is superimposed on the uplink and downlink frequencies.

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Figure 6 shows a transmission/reception process within a transmission/reception cycle which is subdivided into eight timeslots (0 to 7). The semiduplex band (see Figure 6a) allows transmission and reception at the same frequency, with transmission and reception each being carried out in different timeslots. The reference symbol RXs in this case denotes reception, and TXs transmission of signals in the semiduplex band. The semiduplex band timeslots are synchronized to the duplex band timeslots (see Figure 6b) as in the GSM system, but they may differ in the nature of the transmission, and in length. The reference symbol RX denotes reception and TX transmission of signals in the duplex band. Overall, this means that it is possible to work virtually simultaneously in both bands (see Figure 6c).

As shown in Figure 1, a mobile station A communicates with the base station using the duplex mode. In addition, the mobile station A can set up communication using the semiduplex mode with the mobile station B. There is no link between the mobile station B and the base station. It is thus possible for the mobile station A to communicate simultaneously with the base station and the mobile station B.

Figure 2 shows a situation in which the mobile station A is being used as a repeater. As in the situation shown in Figure 1, there is a direct link between the base station and the mobile station A, while there is no direct link between the base station and the mobile station B. However, the mobile station A converts the semiduplex mode information transmission to duplex mode information transmission, and vice versa, so that communication is set up between the base station and the mobile station B. This means that data are transmitted using the semiduplex mode from the mobile station B to the mobile station A, are processed in the mobile station A and are passed on using the duplex mode to the base station and, in the opposite

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direction, are transmitted from the base station to the mobile station A using the duplex mode, are

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processed in the mobile station A, and are passed on to the mobile station B using the semiduplex mode.

As shown in Figure 3, it is likewise possible for the mobile station A to communicate simultaneously with the mobile station B and the mobile station C using the semiduplex mode or, as a repeater, to receive information in the semiduplex mode from the mobile station B, and to pass it on to the other mobile station C using the semiduplex mode (or vice versa).

10 Direct coupling between the mobile stations B and C would be impossible since the mobile station B is located in an area (valley) which is shadowed from the mobile station C.

It is also possible to form a chain comprising 15 a greater number of mobile stations.

The mobile stations have a control device which chooses between operation with one or two further stations or else operation as a repeater. If required, the control device may automatically select operation 20 as a repeater. However, in order to avoid loading the power supply device in a mobile station in an uncontrolled manner, operation as a repeater can be inhibited.

The advantage of the mobile radio system in the 25 present invention, in which mobile stations can be operated as repeaters, is, as described above, that even mobile stations which have no direct link to a base station due to shadowing can set up communication to other mobile stations and to the base station. A 30 further advantage is that a mobile station can likewise be operated from an aircraft. In a conventional mobile radio system, operation of a mobile station from an aircraft while flying is normally impossible since the mobile station cannot set up communication with a 35 specific base station from the large number of accessible base stations. By using

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mobile stations as repeaters which operate at a frequency suitable for them, however, it is possible to set up communication with one base station.

Furthermore, the mobile radio system in the 5 present invention can be designed to be self-organizing. By using new transmission methods such as JD-CMDA, it can provide very high transmission capacities. Such a combined system makes it possible to integrate virtually all the radio and mobile 10 requirements which arise and operate with limited range and, possibly, with high traffic densities: wireless LAN, DSSR digital short range radio, LPD low power devices, TETRA trunked mobile radio and BOS, railroad radio, cordless telephones, mobile telephones, aviation 15 radio, maritime radio, emergency paging systems and cordless buses (for control functions).

In one design variant of the invention, the term duplex mode means a frequency division duplex (FDD) mode, and the term semiduplex mode means a time 20 division duplex (TDD) mode. In this case, different frequency bands can be provided for the uplink (mobile station to base station) for FDD (Frequency Division Duplex) systems, such as the GSM system or UTRA (UMTS (Universal Mobile Telephony System) Terrestrial Radio 25 Access) FDD mode than for the downlink (base station to mobile station), and different time periods can be provided for the uplink and downlink for TDD (Time Division Duplex) systems such as DECT (Digital Enhanced Cordless Telecommunications) system or the UTA (UMTS 30 (Universal Mobile Telephony System) Terrestrial Radio Access) TDD mode.

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## Patent Claims

1. A mobile radio system having a number of mobile stations (A, B, C),

5 with the mobile stations having means for carrying out transmission/reception operation in the duplex mode and in the semiduplex mode.

2. The mobile radio system as claimed in claim 1, characterized in that a first mobile station (A) has

10 means for carrying out transmission/reception operation with a base station in the duplex mode, and with a second mobile station (B) in the semiduplex mode.

3. The mobile radio station as claimed in one of the preceding claims, characterized in that the first

15 mobile station (A) has means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode in such a manner that the transmission/reception operation is carried out

20 cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously with respect to one another.

4. The mobile radio system as claimed in one of the preceding claims, characterized in that the first

25 mobile station (A) has means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station (B) in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted

30 via the first mobile station to the base station, and vice versa.

5. The mobile radio system as claimed in one of the preceding claims, characterized in that the first

35 mobile station (A) has means for carrying out transmission/reception

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operation with the second mobile station (B) and with a third mobile station (C) in the semiduplex mode.

6. The mobile radio system as claimed in one of the preceding claims, characterized in that the first 5 mobile station (A) has means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile 10 station to the third mobile station, and vice versa.

7. The mobile radio system as claimed in one of the preceding claims, characterized in that the mobile stations that are among the number of mobile stations are coupled to one another in such a manner that a 15 communication chain or a communication network is formed.

8. The mobile radio system as claimed in one of the preceding claims, characterized in that the first mobile station (A) has means for manually or 20 automatically switching on and off the transmission of signals from the second mobile station (B) via the first mobile station (A) to the base station or to the third mobile station (C), and vice versa.

9. A mobile station (A) having means for carrying 25 out transmission/reception operation in the duplex mode and in the semiduplex mode.

10. The mobile station (A) as claimed in claim 9, having means for carrying out transmission/reception operation with a base station in the duplex mode and 30 with a second mobile station (B) in the semiduplex mode.

11. The mobile station (A) as claimed in one of claims 9 or 10, having means for carrying out transmission/reception operation with the base station 35 in the duplex mode, and with the second

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mobile station (B) in the semiduplex mode, in such a manner that the transmission/reception operation is carried out cyclically in timeslots, and the timeslots for the duplex and semiduplex mode run synchronously  
5 with respect to one another.

12. The mobile station (A) as claimed in one of claims 9 to 11, having means for carrying out transmission/reception operation with the base station in the duplex mode and with the second mobile station  
10 (B) in the semiduplex mode, in such a manner that signals from the second mobile station are transmitted via the first mobile station to the base station, and vice versa.

13. The mobile station (A) as claimed in one of claims 9 to 12, having means for carrying out transmission/reception operation with the second mobile station (B) and with a third mobile station (C) in the semiduplex mode.

14. The mobile station (A) as claimed in one of claims 9 to 13, having means for carrying out transmission/reception operation with the second (B) and the third (C) mobile station in the semiduplex mode in such a manner that signals from the second mobile station are transmitted via the first mobile station to  
25 the third mobile station, and vice versa.

15. The mobile station (A) as claimed in one of claims 9 to 14, having means for manually or automatically switching on and off the transmission of signals from the second mobile station (B) via the  
30 first mobile station (A) to the base station or to the third mobile station (C), and vice versa.

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Abstract

Mobile radio system, and a mobile station

A mobile radio system contains a number of mobile stations, with the mobile stations having means for carrying out transmission/reception operation in the duplex mode and in the semiduplex mode.